



Space Interferometry Mission

Presented by

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Project Manager

Space Interferometry Mission

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SIM

A NASA
Origins
Mission

- 3 Michelson Stellar Interferometers
- 10 meter baseline
- Visible wavelength
- Launch Vehicle: Space Shuttle or EELV
- Earth-trailing solar orbit
- 5 year mission life with 10 year goal
- SIM is a JPL, Caltech, Lockheed Martin, TRW, and The SIM Science Team partnership



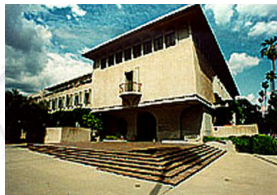
The SIM Partnership: Many Partners One Team



Metrology Subsystem
Starlight Subsystem
Interferometer I&T
Interferometer Operations



Interferometry Science Center



Science Data Analysis and
Archiving
Science Operations
Science Planning
Science Community Interface
Outreach



SIM Science Team

UC Berkeley
JPL
Ohio State University
Raytheon ITSS
USNO
Dartmouth College
Georgia State University
University of Virginia
Caltech
St. Ambrose University
UC San Diego
STSI



Spacecraft
Precision Support Structure
Assembly, Test, & Launch
Operations
S/C Operations



Project Management
System Engineering
Integrated Modeling
Real Time Control Subsystem
Mission Systems
Mission Assurance
Risk Management

SIM Science Team Selected

Key Science Projects

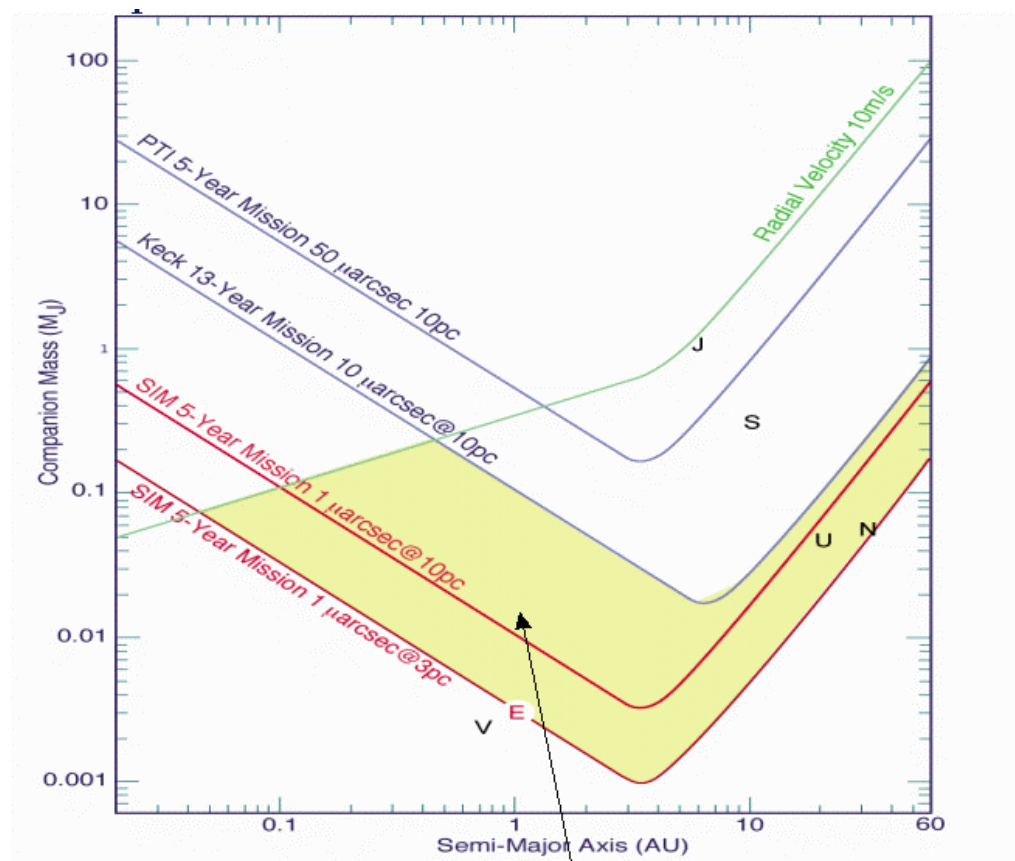
<u>Names</u>	<u>Institutions</u>	<u>Topic</u>
Dr. Geoffrey Marcy	University of California, Berkeley	Planetary Systems
Dr. Michael Shao	NASA/JPL	Extrasolar Planets
Dr. Charles Beichman	NASA/JPL	Young Planetary Systems and Stars
Dr. Andrew Gould	Ohio State University	Astrometric Micro-Lensing
Dr. Edward Shaya	Raytheon ITSS Corporation	Dynamic Observations of Galaxies
Dr. Kenneth Johnston	U.S. Naval Observatory	Reference Frame-Tie Objects
Dr. Brian Chaboyer Clusters	Dartmouth College	Population II Distances & Globular Ages
Dr. Todd Henry	Georgia State University	Stellar Mass-Luminosity Relation
Dr. Steven Majewski	University of Virginia	Measuring the Milky Way
Dr. Ann Wehrle	NASA/JPL	Active Galactic Nuclei

Mission Scientists

Dr. Guy Worthey	St. Ambrose College	Education & Public Outreach Scientist
Dr. Andreas Quirrenbach	University of California, San Diego	Data Scientist
Dr. Stuart Shaklan	JPL	Instrument Scientist
Dr. Shrinivas Kulkarni	California Institute of Technology	Interdisciplinary Scientist
Dr. Ronald Allen	Space Telescope Science Institute	Imaging and Nulling Scientist

Astrometric Planet Detection

- SIM will search for ~3 Earth mass planets in the habitable zone around ~250 stars within 10 parsecs
- SIM will survey ~2000 stars within 20 parsecs to find planetary systems like our own (Jovian planets in Jovian orbits). SIM will place our solar system and its planets in the context of planetary systems in this part of the galaxy
- SIM will study the birth of planetary systems around young stars to understand how planetary systems evolve



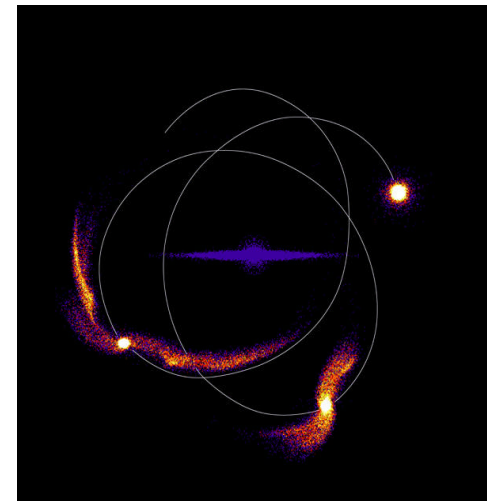
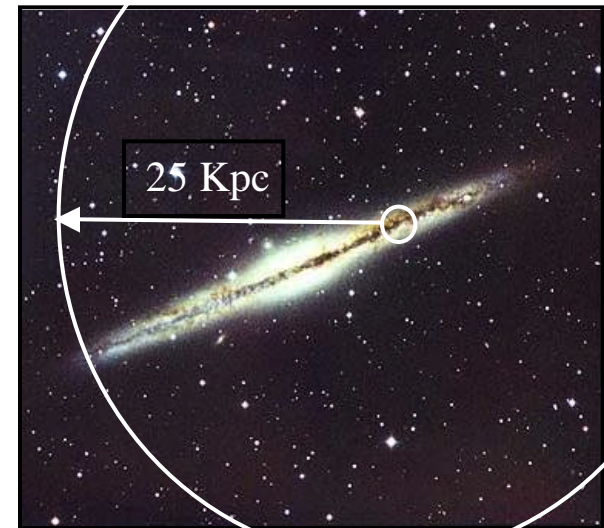
Systems Only Accessible by SIM

Astrophysics with SIM

New Discoveries ...

And answers to age-old questions

- Calibration of the Cosmic Distance Scale
 - Cepheids and nearby spiral galaxies
- Dynamics of the Galaxy
- Fundamental stellar astrophysics
- Masses of Black hole and neutron star binaries
- Probe Nature of Dark Matter via gravitational lensing
- Dynamics of the Local Group of galaxies, dark matter in nearby galaxies, and between galaxies
- Frame tie between SIM (optical) and ICRF (radio)



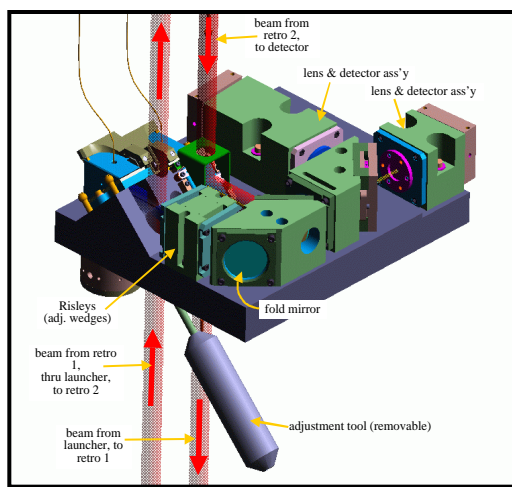
SIM Put the “T” in TPF

- SIM provides a critical piece of information, planet masses, for TPF to know if it is imaging a Terrestrial Planet or an Ice Giant
- SIM provides necessary technology for TPF
 - Demonstrates interferometry in space
 - Demonstration of optical pathlength measurements to ~250 picometer and control at ~1 nanometer on a large flexible structure required for TPF nulling
 - If TPF is a coronagraph system, SIM provides the technology for measuring and controlling optical wavefronts at the required 100 picometer level
 - Laboratory demonstration of nulling
- SIM will identify targets for TPF
 - SIM will search virtually every single star (~250) within 10 parsec for planets down to a few Earth masses in the habitable zone
 - SIM will search virtually every single star (~2000) within 20 parsec to determine the architecture of planetary systems in our neighborhood. SIM will search every star that TPF can detect an Earth around.
- If SIM finds an adequate number of planets within <10 parsec, TPF requirements/cost could be significantly reduced

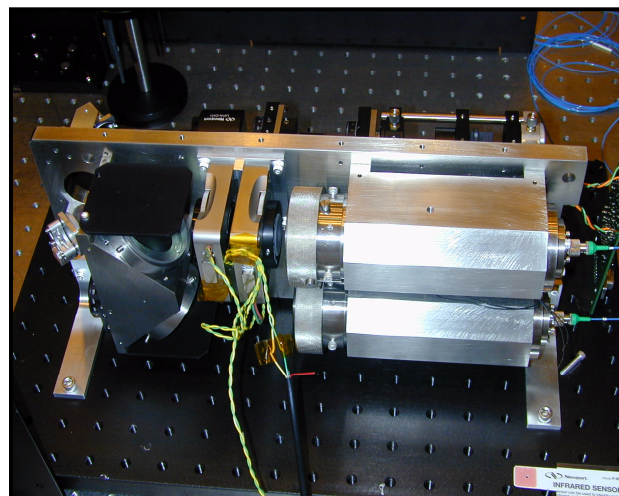
Technology Progress

Beam Launcher Status

- Lab proof-of-concept demonstration of new (next generation) beam launcher produced in-spec measurement performance of 20pm cyclic error and thermal performance of 1pm/mK
- Flight form factor brassboards of the new (next generation) internal and external launcher designs are in process
 - SAVV (sub-aperture vertex-vertex) version of internal launcher should be complete with initial test data by May
 - Will be incorporated into the MAM-1 Testbed by June
 - Quick prototype (QP) external launcher should be complete with initial test data in June



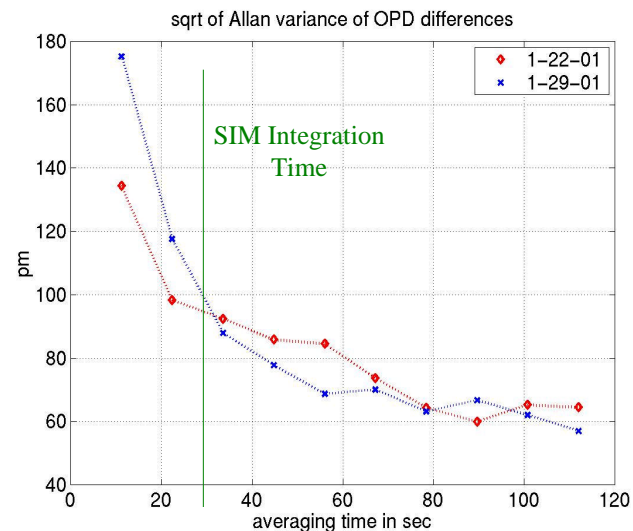
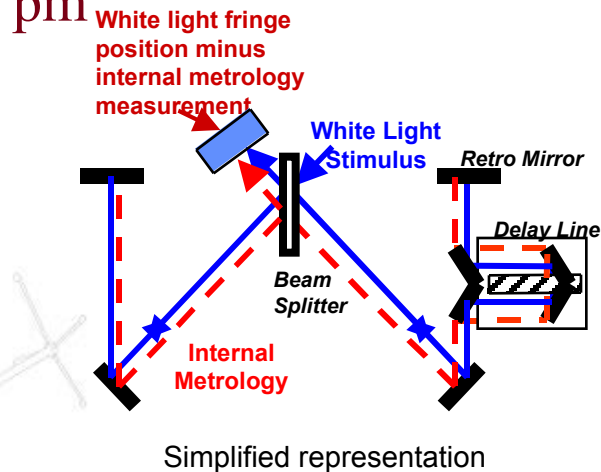
QP External Beam Launcher



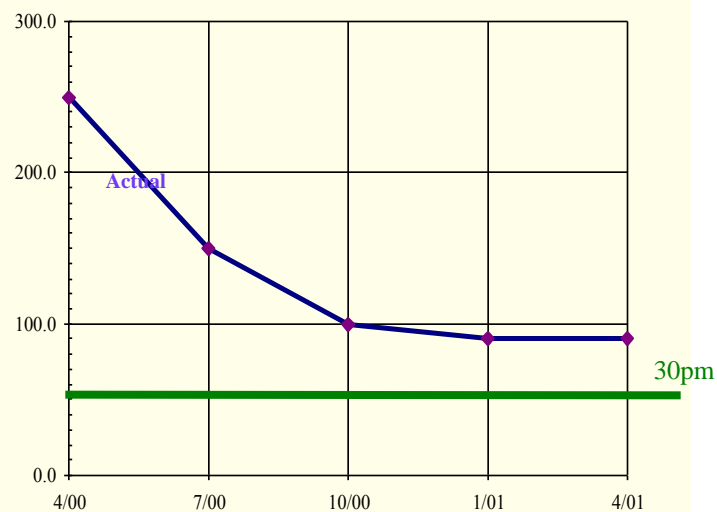
SAVV Internal Beam Launcher

White Light Experiment

- Objective: demonstrate white light fringe position measurement at the picometer level
- Performance goal: 10 - 30 pm
- Current performance: 90 pm

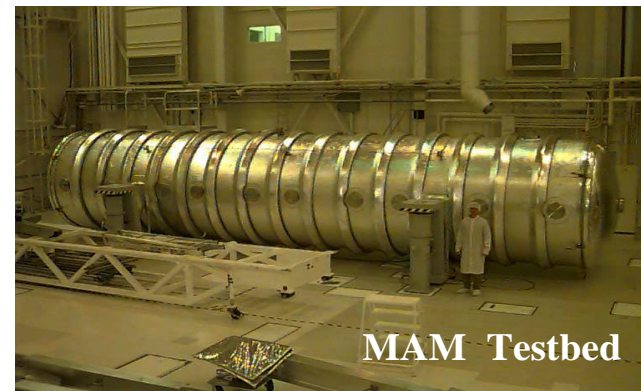
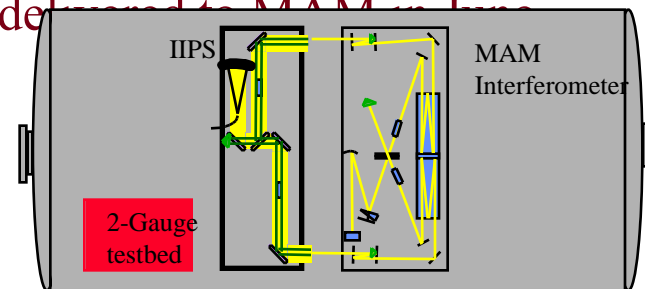
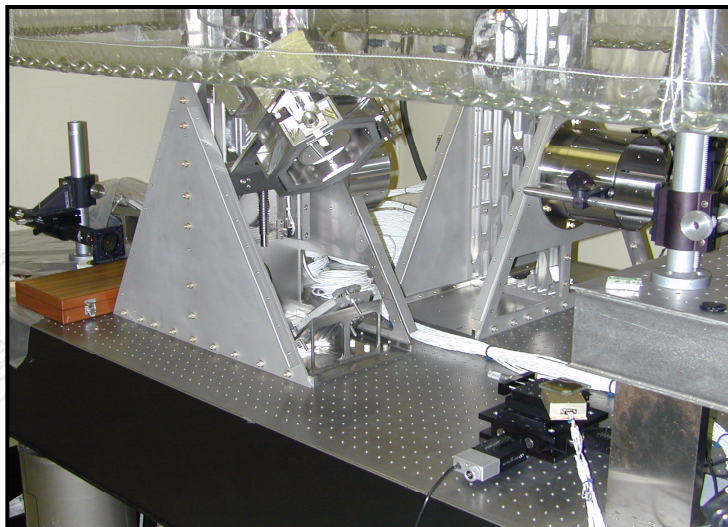


White light - Metrology (Picometer RMS)



Picometer Technology System-Level Validation Microarcsecond Metrology Testbed (MAM-1)

- Back end of testbed interferometer operational in MAM-1 vacuum tank
 - White light experiment
- Lockheed Martin completed the inverse interferometer pseudostar (IIPS), and it has been delivered to JPL
- Integration of IIPS to MAM-1 test article to begin this spring
- Interim SAVV beam launcher will be delivered to MAM in June
- Expect “first fringes” this fall

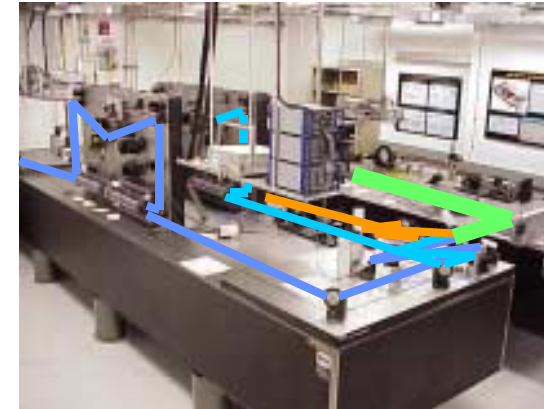
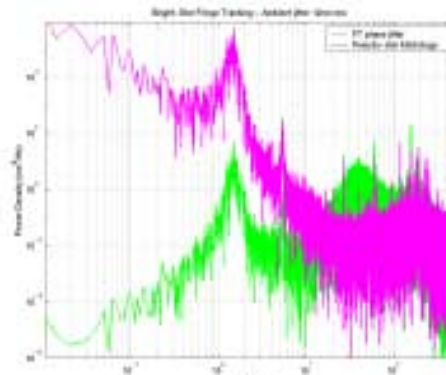
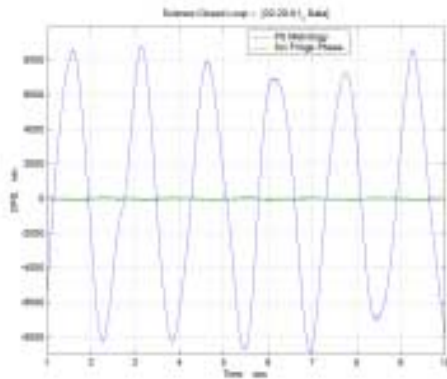


MAM Testbed

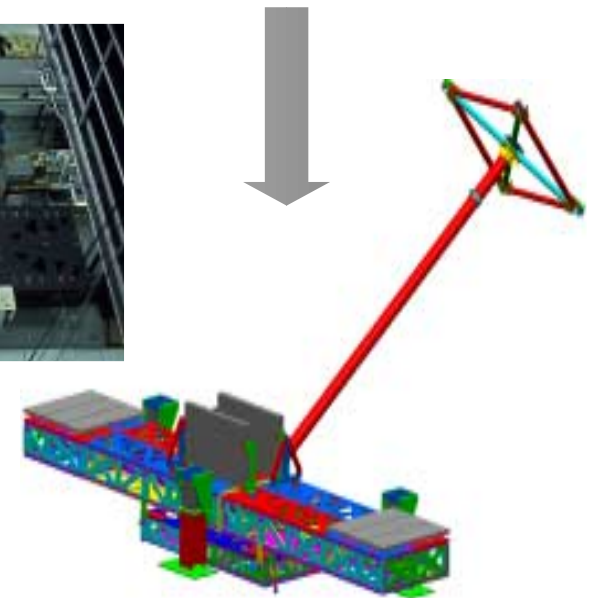
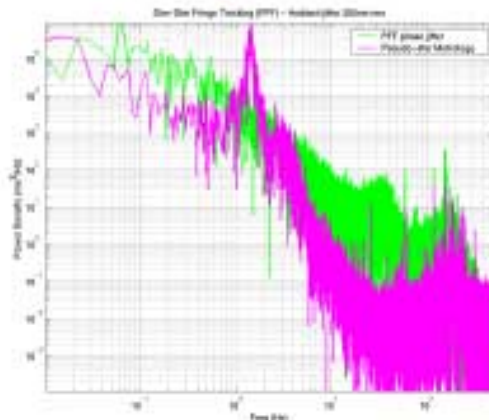
Nano Technology Nearing Completion

SIM System Testbed (STB-3)

**Achieved Better Than Required 50dB at 1 Hz
Closed Loop Performance on Guide Stars**



**Science Star Closed Loop
Performance Currently at 20dB**

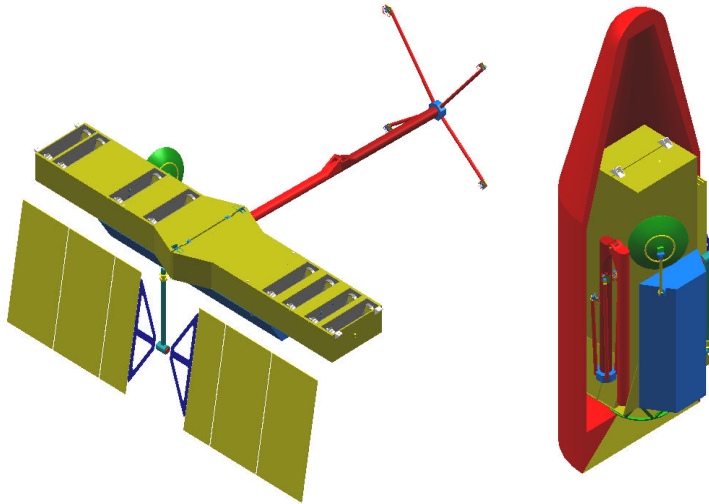


SIM Redesign Activity

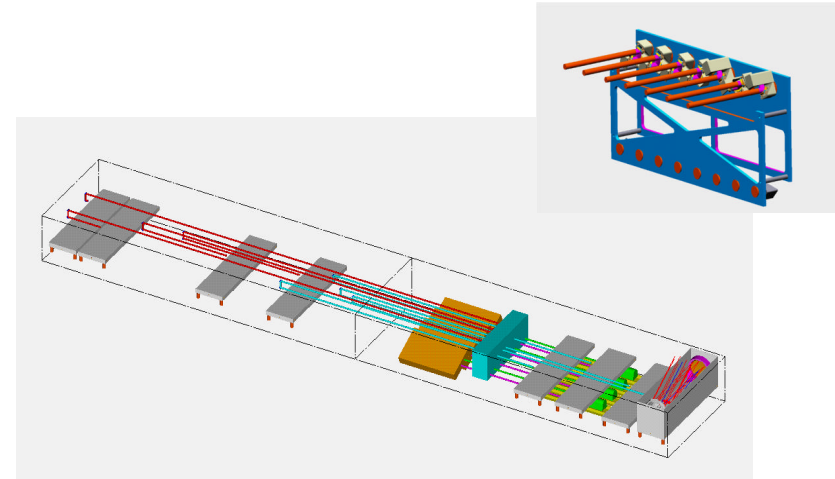
- SIM team (JPL, ISC, Lockheed Martin, TRW, and the SIM Science Team) fully engaged in a redesign study
- New SIM Shared Baseline design preserves over 90% of the original SIM science
- Shared Baseline design resulted in a sizeable cost reduction and a large reduction in risk
 - Monolithic Precision Structure eliminates technical risk (thermal and micro-dynamics effects of deployment)
 - External metrology system greatly reduced (50% reduction in external metrology beams, and elimination of the 9 meter metrology boom and kite)
 - 50% reduction in overall mechanism count
 - Significant reduction in optical complexity

SIM Complexity Significantly Reduced

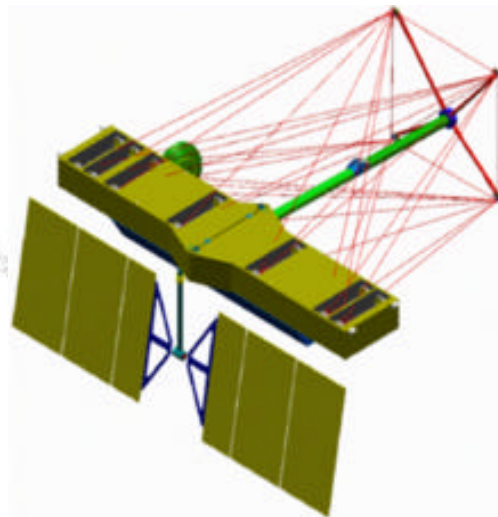
Space Interferometry Mission



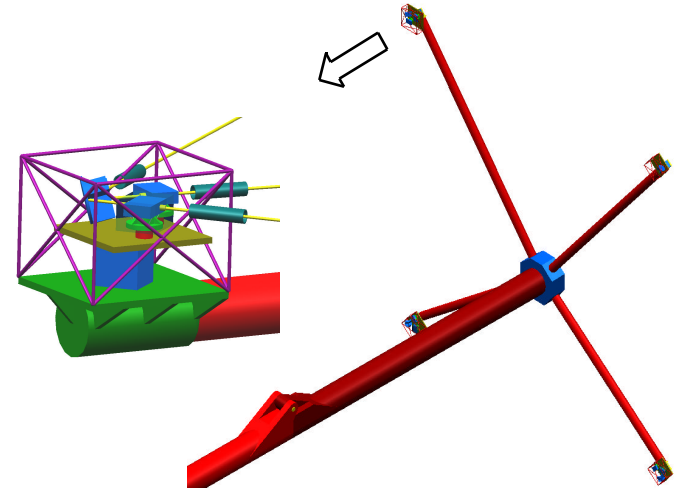
Folding Structure - *Eliminated*



Switchyard and Associated Optics - *Eliminated*



External Metrology - *Significantly Simplified*

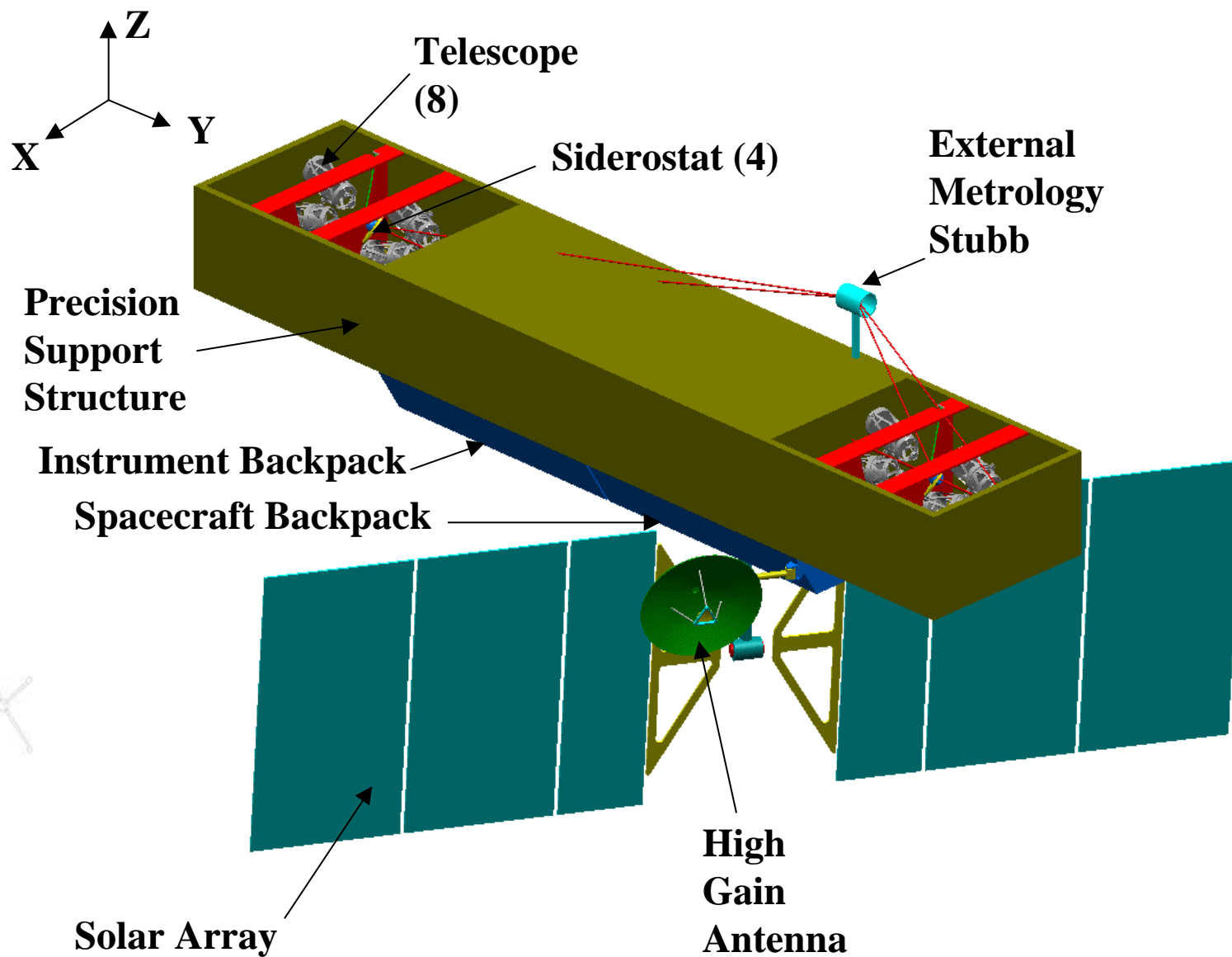


Complex Metrology Boom and Kite - *Eliminated*

SIM

A NASA
Origins
Mission

SIM Flight System Configuration



Coming Next Year

- Achieve key performance level with flight-like brassboards of the new (next generation) beam launchers
 - $\leq 100\text{pm}$ uncompensated cyclic error
 - $\leq 20\text{pm/mK}$ thermal sensitivity
- Demonstrate dim star fringe tracking stabilization performance requirements on STB-3
- Obtain first fringes on MAM-1 this fall, leading to a performance demonstration of 150pm by June 2002
- Develop design details and Level 1, 2 & 3 requirements for the new SIM Reference Design (Shared Baseline)
- Prepare for the Mission Definition Review

Space Interferometry Mission



PDR = Preliminary Design Review ICR = Initial Confirmation Review (Code S)
NASA PMC = Programmatic Management Council (APP = Approved)

Outreach Highlights - Taking the Measure of the Universe

Classroom Activities Address Challenging Science Subject



“Scales and Distances”, a challenging concept for most students and teachers, is illustrated by three classroom activities. Activities start with objects familiar to the students and expand the concept to the solar system and the Milky Way Galaxy.

Collaboration in small teams is facilitated and encouraged by the instructors.

Attractive artwork enhances the presentation of the activities.

- Activities have been presented at regional and national science and math teacher conventions (such as CSTA, NSTA, NCTM)
- Product has received enthusiastic response from teachers of integrated math and science
- SIM Educational exhibit is based on the same artwork

Takeaway Chart

- SIM completed an Independent Assessment (IA) by the Langley
- SIM Science Team is on board
- The new SIM design concept significantly reduces cost and risk
- The new SIM design concept meets all the requirements of Dr. Weiler's letter
 - Unique and important science
 - Identifies targets for TPF including the masses of the planets
 - Determines planetary architectures in our neighborhood
 - IPAO Independent Cost Estimate is well within 20% of the SIM Project cost estimate
- We have identified the critical technology milestones required for entry into Phase B and Phase C/D

For more information about the Space Interferometer
Mission,

visit our web site:

<http://sim.ipl.nasa.gov>

